ON THE SHAPE PARAMETERS OF MQ RADIAL BASIS FUNCTION USED IN THE HEAVISIDE WEIGHTED MESHLESS METHOD FOR TWO-DIMENSIONAL SOLIDS

J. R. Xiao, B. A. Gama, and J. W. Gillespie Jr.

Center for Composite Materials
University of Delaware
Newark, DE 19716, USA
xiaoj@ccm.udel.edu

During the past few years the idea of using meshless methods for numerical solution of partial differential equations (PDFs) has received much attention throughout the scientific community, and remarkable progress has been achieved on meshless methods. As a few representative examples we mention the Element-Free Galerkin (EFG) Method by Belytschko and co-workers [1], the Reproducing Kernel Particle Method (RKPM) by Liu and co-workers [2], hp-clouds method by Duarte and Oden [3], the Partition of Unity Method (PUM) by Babuska and Melenk [4] and the Meshless Local Petrov-Galerkin (MLPG) method [5]. However, there exist some inconveniences in most of the above-mentioned meshless methods, mainly due to the interpolation schemes and corresponding numerical integration difficulties. The obtained shape functions from the interpolation schemes (MLS, PUM, RKPM, Shepard function, etc.) in these meshless methods are rational functions (non-polynomial functions) and lack the delta function property, which makes their application burdensome.

Very recently, a local weighted meshless method [6] has been developed, based on the idea of MLPG5 in [5], for the stress analysis of two-dimensional solids using the Heaviside step function as the weighting function over a local subdomain. Trial functions are constructed using the extended multiquadrics (MQ): $g(r) = (r^2 + c^2)^{\beta}$ [7]. In the present method the integration difficulties have been removed as there is no domain integral and only a regular boundary integral along the edges of subdomains is involved. The obtained shape functions possess the delta function property, so no special treatment is needed to impose the essential boundary conditions. However, the behaviour of shape parameters β and c are still open issues. It is of interest to know how the shape parameters affect the performance of the present method. In the present paper, the behaviour of shape parameters of MQ radial basis function will be systematically studied by comparing the present numerical results with closed-form solutions of example problems in elastostatics.

References

[1] T. Belytschko, Y. Lu, L. Gu, "Element-free Galerkin methods," *International Journal of Numerical Methods in Engineering*, v. 37, p. 229-256, 1994.
[2] W.K. Liu, S. Jun, Y. Zhang, "Reproducing kernel particle methods," *International Journal of Numerical Methods in Fluids*, v. 20, p. 1081-1106, 1995.
[3] C.A. Duarte, J.T. Oden, "An h-p adaptive method using clouds," *Computer Methods in Applied Mechanics and Engineering*, v. 139, p. 237-262, 1996.
[4] I. Babuska, J. Melenk, "The partition of unity method," *International Journal of Numerical Methods in Engineering*, v. 40, p. 727-758, 1997.
[5] S.N. Atluri, S. Shen, *The meshless local Petrov-Galerkin (MLPG) method*. Tech. Science Press, 2002.
[6] J.R. Xiao, M.A. McCarthy, "A local Heaviside weighted meshless method for two-dimensional solids using radial basis functions," *Computational Mechanics*, 2003 (tentatively accepted).
[7] J.G. Wang and G.R. Liu, "A point interpolation meshless method based on radial basis functions," *International Journal of Numerical Methods in Engineering*, v. 54, p. 1623-1648, 2002.